DESIGN OF DETENTION TANK AND DRAINAGE SYSTEM FOR STORMWATER MANAGEMENT NEAR SM CALOOCAN CITY

An Experimental Research

Presented to the Faculty of Civil Engineering

Division La Concepcion College

In Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Civil Engineering Major in Construction Engineering and Management

Jolo M. Domingo

Jandy D. Ecao

Jerann C. Lagundi

Emilyn S. Lancero

2026

RECOMMENDATION

This is to certify that this research, titled "DESIGN OF DETENTION TANK AND DRAINAGE SYSTEM FOR STORMWATER MANAGEMENT NEAR SM CALOOCAN CITY ", prepared and submitted by Jolo M. Domingo, Jandy D. Ecao, Jerann C. Lagundi, and Emilyn S. Lancero,in partial fulfillment of the requirements for the degree Bachelor of Science in Civil Engineering major in Construction Engineering and Management, is hereby recommended for Pre-Oral Defense.

Eng. ELOISA P. CADAG,Reg. CE., MACT
Research Adviser

PANEL OF EXAMINERS

Examined and approved by the Panel of Examiners in an Oral Examination With a grade of _____on November _____, 2025, at La Concepcion College, Bulacan.

Engr. DANILO A. CASAS, LPT,MaED
Chairman

Engr. CAROLINE A. ASUNCION Member

Engr. CAMILO A. BATULAN JR., MSCM Member

Accepted and approved in partial fulfillment of the requirements for the degree Bachelor of Secondary Education Major in English.

ENGR. JORE GIL D. GALEZA
Division Head Civil Engineering Division

LEILANI I. CUSACK, Ph.D, DBA
Dean of Instruction

CERTIFICATE OF ORIGINALITY

We hereby certify that this thesis is our own work and that to the best of our knowledge and belief, it contains no material previously written or published by another person or organization nor any material which has been accepted for award of any other degree or diploma from a university or institution of higher learning, except where due acknowledgement is made thereof.

Furthermore, we declare that the intellectual content of this thesis is the product of our work although we have received assistance from others on the manner of organization, presentation, language, and style.

Jolo M. Domingo
Jandy D.Ecao
Jerann C. Lagundi
Emilyn S. Lancero

Attested by:

Engr. Eloisa P. Cadag, Reg. CE., MACT
Research Adviser

Date:_____

ACKNOWLEDGMENTS

The completion of this research could not have been possible without the participation and assistance of so many people whose names may not all be enumerated. Their contributions are sincerely appreciated and gratefully acknowledged.

The group would like to express their deep appreciation and indebtedness particularly to the following:

Engr. Eloisa Cadag, our thesis adviser, **Engr. Jore Gil D. Galeza**, our division head; for their endless support, kind and understanding spirit during our research study.

All relatives, friends and others who, in one way or another, shared their support, either morally or financially, thank you. Above all, The Great Almighty, the Author of knowledge and wisdom, our never-ending gratitude for your immeasurable love.

We thank you.

TABLE OF CONTENTS

Page

TITLE PAGE i

RECOMMENDATION ii

CERTIFICATE OF ORIGINALITY iii

ACKNOWLEDGEMENTS iv

CHAPTER 1

THE PROBLEM AND ITS BACKGROUND

Introduction… 1

Background of the Study. 2

Theoretical Framework. 5

IPO Conceptual Framework… 6

Statement of the Problem 10

Objectives of the Study. 11

Hypothesis 12

Significance of the Study. 12

Scope and Limitation of the Study… 13

Definition of Terms 15

CHAPTER 2

REVIEW OF RELATED LITERATURE

Foreign Literature. 16

Local Literature. 19

Foreign Studies 21

Local Studies 23

Synthesis of Review of Related Literature and Studies 25

CHAPTER 3

RESEARCH METHODOLOGY

Research Design 27

Sample and Population. 27

Research Instrument 28

Research Design 28

Design and Equipment 29

Data Gathering Procedure. 30

Statistical Treatment 32

CHAPTER 1

PROBLEM AND ITS BACKGROUND

Introduction

The Philippines is "the most exposed country in the world to tropical storms" according to Time Magazine. Approximately twenty tropical cyclones enter the Philippine Area of Responsibility (PAR), ten will be typhoons, with five having the potential to be destructive ones. According to the report of the Office of Civil Defense and National Risk Reduction Management Council, approximately five hundred to thousands of people every year are killed and/or missing due to floods brought by the typhoons.

Urban areas like Caloocan City are facing issues regarding flooding in their areas due to many infrastructure constructions, poor drainage system design and climate change. Heavy rains cause inconvenience to residents in the said area especially in transportation, flood can damage properties and above all pose a risk to the health and safety of residents. One of the areas affected by the flood is near SM Caloocan City.

Detention tanks play an important role in the flooding control in the downstream areas of the urban stormwater drainage system (USDS) during the wet weather seasons. For complex watersheds with specific local flooding control policies, the conventional optimization and design methods are found to be not sufficient for effectively and optimally locating and sizing appropriate detention tanks any more. This paper investigates the optimal design of detention tanks under the constraints of

local flooding control criteria, with the aim to develop an efficient and robust method and framework for the design of the detention tank network.

Background of the Study

Floods usually occur in urban areas where urbanization is rapid, usual flood control measures such as drainage system enhancement is insufficient in managing heavy rainfalls and it causes damage to property it also affects the small business owners it also affects the traffic flow and the commuters. The studies in detention tanks in local areas is insufficient. This gap provides the context for investigating the potential of detention tanks as a sustainable flood mitigation strategy. This study also applies multi-objective operation by combining detention tanks for flood control with water reuse for the public purpose.

The area surrounding SM Caloocan City, a major commercial and transportation hub in Metro Manila, frequently experiences flooding and flash floods during heavy rains. The high concentration of commercial establishments, concrete sidewalks, and limited green spaces contribute significantly to the reduced permeability of the area. These conditions highlight the urgent need for an effective and sustainable stormwater management system that can reduce flooding and enhance the resilience of cities.

Detention tanks are used to store stormwater temporarily during heavy rainfall to reduce the chance of flooding and often released in natural channels and sewers at a controlled rate. There are important design factors in planning a detention tank such

as the chances of heavy rainfall in a month or a year, and the volume of water that can be stored. Detention tanks can significantly reduce peak flow from storm events, depending on their storage volume relative and how many tanks are installed.

Detention tanks are used and recognized worldwide as an effective stormwater management system, most of the studies focus on large areas and urban areas with advanced infrastructure. The lack of study in small or medium sized communities, particularly in the Philippines because it is a tropical county where heavy rainfall more often occurs. This lack of localized studies creates uncertainty in designing appropriate detention systems for flood-prone communities. Addressing this issue, the present study evaluates the feasibility and effectiveness of detention tanks as a sustainable flood mitigation strategy in a local setting.

These flooding issues can be resolved with a detention tank that helps to reduce flooding and helps nearby homes and infrastructure minimize damage to their property. The detention tank can store rainwater and it will be disposed of in the creek near the area. This study will show that detention tanks will help to reduce the risk of flooding. Studies have shown that detention tanks are effective in flood mitigation but there is still a need for localized research on their design, capacity, and performance in specific contexts, especially in flood-prone areas in the Philippines. The spread of leptospirosis will be prevented because rainwater will be directed to the detention tank and it will be dispose in creek.

Figure 1: Location of the study area

Theoretical Framework

This study is grounded in established theories and principles related to hydrology, stormwater management, and urban infrastructure design. These theories form the basis for understanding the behavior of rainfall runoff in urban environments and guide

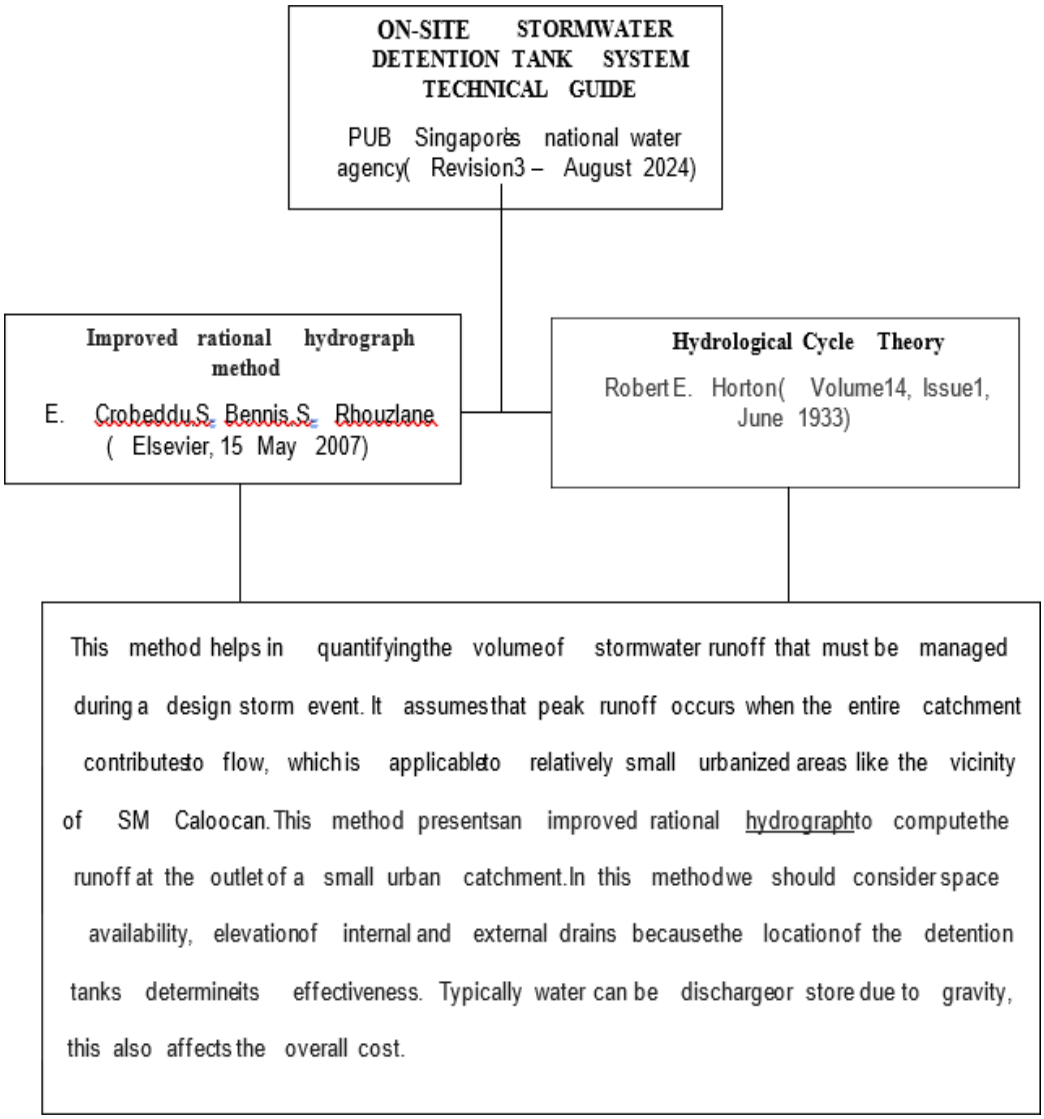
ON-SITE STORMWATER DETENTION TANK SYSTEM TECHNICAL GUIDE
PUB Singapore's national water agency(Revision3 – August 2024)
Improved rational hydrograph method
E. Crobeddu,S. Bennis,S. Rhouzlane (Elsevier, 15 May 2007)
Hydrological Cycle Theory
Robert E. Horton(Volume14, Issue1, June 1933)
This method helps in quantifyingthe volumeof stormwater runoff that must be managed during a design storm event. It assumesthat peak runoff occurs when the entire catchment contributesto flow, whichis applicableto relatively small urbanized areas like the vicinity of SM Caloocan. This method presentsan improved rational hydrographto computethe runoff at the outletof a small urban catchment.In this methodwe should considerspace availability, elevationof internal and external drains becausethe locationof the detention tanks determineits effectiveness. Typically water can be dischargeor store due to gravity, this also affectsthe overall cost.

Figure 2. Theoretical Framework

IPO Conceptual Framework

Input	Process	Output
1. What is the current condition of the drainage system in the area near SM Caloocan City in terms of : 1.1 Flood control effectiveness 1.2 Design 2. How does a detention tank with drainage system benefit in terms of: 2.1 Economic 2.2 Social	1. To determine demographic profile of the respondents based on their: 1.1. Age 1.2. Sex 1.3. Occupation 1.4. Residence Type 1.5. Flooding Experience 2. To the current condition of the drainage system in the area near SM Caloocan City in terms of:	

2.3 Environment 3. How does the physical properties of the detention tank with drainage system affect their ability to manage stormwater during heavy rainfall in terms of: 3.1 Water capacity 3.2 Efficiency 4. How do the mechanical features of the detention tank and drainage system affect how well	2.1 Flood control effectiveness 2.2 Design 3. To learn about the benefits of a detention tank with drainage system in terms of: 3.1 Economic 3.2 Social 3.3 Environment 4. To assess how does the physical properties of the detention tank with drainage system affect their ability to manage stormwater during heavy rainfall in terms of: 4.1 Water capacity 4.2 Efficiency	

they work to stop floods in terms of: 4.1 Compressive strength 4.2 Tensile and flexural strength 4.3 Shear strength 4.4 Permeability	5. To identify how do the mechanical properties of a detention tank with drainage system affect flood prevention in terms of: 5.1 Compressive strength 5.2 Tensile and flexural strength 5.3 Shear strength 5.4 Permeability	

Table 1. IPO Conceptual Framework

Conceptual Framework

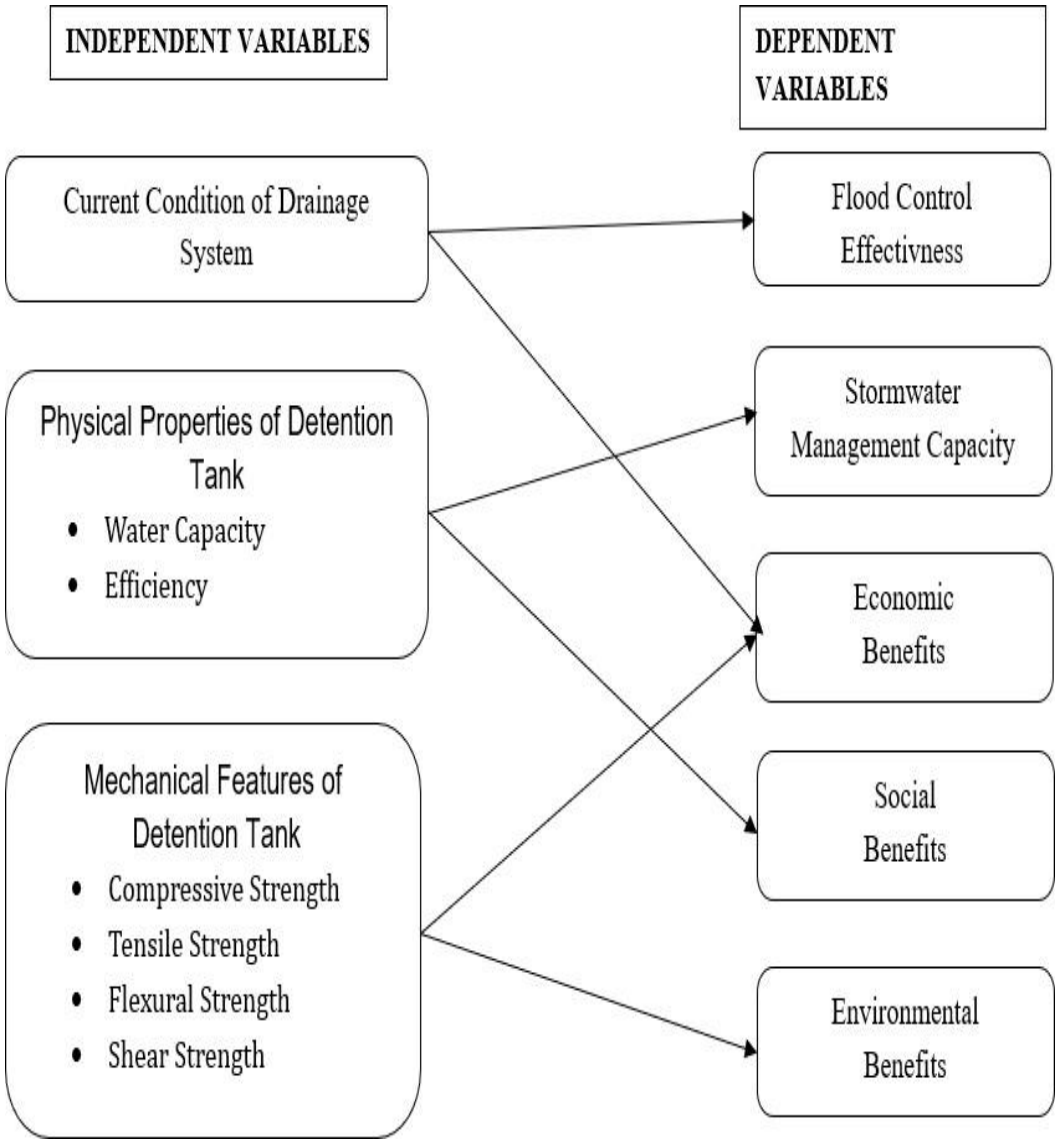

Figure 3. The Conceptual Framework illustration the relationship between the variables

Statement of the Problem

This study aims to answer the following research questions bellow:

1. How may the demographic profile of the respondents be described in terms of:

    1.1. Age

    1.2. Sex

    1.3. Occupation

    1.4. Residence type

    1.5. Flooding Experience

2. What is the current condition of the drainage system in the area near SM Caloocan City in terms of:

    2.1 Flood control effectiveness

    2.2 Design

3. How does a detention tank with drainage system benefit in terms of:

    3.1 Social

    3.2 Environment

4. How does the physical properties of the detention tank with drainage system affect their ability to manage stormwater during heavy rainfall in terms of:

    4.1 Water capacity

    4.2 Efficiency

5. How do the mechanical properties of a detention tank with drainage system affect flood prevention in terms of:

    5.1 Compressive strength

5.2 Tensile and flexural strength

5.3 Shear strength

5.4 Permeability

Objectives of the Study

This study aims to design a detention tank with an integrated drainage system for effective stormwater management near SM Caloocan City. The objectives are:

1. To determine demographic profie of the respondents based on their:

1.1. Age

1.2. Sex

1.3. Occupation

1.4. Residence Type

1.5. Flooding Experience

2. To the current condition of the drainage system in the area near SM Caloocan City in terms of:

2.1 Flood control effectiveness

2.2 Design

3. To learn about the benefits of a detention tank with drainage system in terms of:

3.1 Economic

3.2 Social

3.3 Environment

4. To assess how does the physical properties of the detention tank with drainage system affect their ability to manage stormwater during heavy rainfall in terms of:

4.1 Water capacity

4.2 Efficiency

5. To identify how do the mechanical properties of a detention tank with drainage system affect flood prevention in terms of:

5.1 Compressive strength

5.2 Tensile and flexural strength

5.3 Shear strength

5.4 Permeability

Hypothesis

Ho: There is no significant effect of the designed detention tank with drainage system on improving stormwater management and reducing flooding near SM Caloocan City.

Ha: There is a significant effect of the designed detention tank with drainage system on improving stormwater management and reducing flooding near SM Caloocan City.

Significance of the Study

This study aims to address the growing concern of urban flooding and ineffective stormwater management near SM Caloocan City, by proposing the design

of a detention tank integrated with a drainage system. The significance of this research is outlined below for various key stakeholders:

Local Government of Caloocan City:

This study can provide recommendations for designing infrastructure to be built that aims to prevent flooding in an area. This process can be a guide for the construction of public works projects that aim to reduce flooding and improve urban resilience, especially in Caloocan City.

Community Residents and Business Owners near SM Caloocan City:

The implementation of an effective stormwater management system will directly benefit local residents and establishments by reducing the risk of property damage, health hazards, and economic losses from frequent flooding.

Engineers

This research has an important contribution for urban areas like Caloocan City to maintain a proper drainage system and prevent flooding in an area. It can be a reference for professionals like engineers for their flood control plans.

Environment

This study will help in the development of an area like Caloocan City by helping to promote eco- friendly stormwater management that will reduce flooding in an area and further improve water quality. It goes along with efforts to protect the environment and plans to deal with climate change.

Future Researchers

The findings of this study can be useful in the field of hydrology, drainage design and urban infrastructure. It provides a way for us to explore the development of infrastructure to reduce flooding in an area.

Scope and Limitations of the Study

The scope of this study focuses on near SM Caloocan City designing a detention tank and drainage system for storm water management. This research is to design the catchment area including its size, shape and inlet/outlet structures, and the design of the drainage system is to transfer the stormwater to the tank and release it at a fire hydrant. The study has a consideration with these two requirements: stormwater and weather conditions. The coverage of this study is limited to the area surrounding near SM Caloocan City, due to its weakness to flooding and the availability of detailed hydrological data for this region.

This study is subject to several limitations providing a design proposal of a detention tank and drainage system for stormwater management near at SM Caloocan City. The design will be focused on the conceptual stage and will not include actual construction or implementation. It is also cover the computation of exact tank size, outlet dimensions, or detailed cost estimates. It will also include environmental impact assessment, or long-term maintenance planning. In addition, the findings of this study will depend on the availability and accuracy of rainfall data and site information

Definition of Terms

For better clarification and understanding of the terms related to this study, the following terms are defined conceptually and operationally.

Detention tank. This refers to a structure designed to temporarily store a stormwater and release it at a controlled amount to prevent flooding and also to reduce peak discharge.

Drainage system. This refers to the infrastructure designed to control and manage the release and accumulation of liquids, influenced by topography and climate conditions.

Flooding. This refers to overflowing of water onto land that is normally dry often caused by heavy rainfall or insufficient drainage capacity.

Stormwater management. This refers to a process of controlling and using stormwater runoff in a way of reducing flood and other related problems.

CHAPTER 2

REVIEW OF RELATED LITERATURES AND STUDIES

This chapter presents the relevant literature and studies that the researcher considered in strengthening the importance of the present study. It also presents the synthesis of the art to fully understand the research for better comprehension of the study.

Foreign literature

In recent times, human activities for urbanization and climate change have also triggered flooding and damage to the drainage system due to water overflow. A detention tank is one of the ways to control flooding by storing water and filtering it for domestic use. Different positions of detention tanks within catchment not only have different impacts on upstream and downstream drainage system performance and their designed efficiencies but also have a strong influence on other parts of the drainage system and network of detention tanks.

The detention tank with a drainage system plays an important role in flood control because it collects the flood caused by heavy rain and prevents the overflow of water in the drainage. If water accumulates in the detention tank, it can be filtered and distributed to nearby establishments. Socially, it improves the safety of people and reduces property damage. Economically, it reduces the cost of repairing damage caused by floods and strengthens the infrastructure in the area. Environmentally, they mitigate pollution by controlling runoff quality and protecting aquatic ecosystems.

Studies highlight their effectiveness in managing stormwater under climate variability, promoting sustainable urban drainage, and supporting water reuse initiatives, which collectively contribute to long-term urban sustainability and cost savings.

According to Van duin et al. (2021) who analyzed urban flooding due to climate change, the detention tank with drainage system is being improved to be prepared for future storms or climate change. Their modeling showed a 30% decrease in flood exposure for social infrastructure like schools and hospitals, fostering greater social cohesion and adaptive capacity in flood-prone regions. The benefits for the residents there are significant because there is a 25-30% reduction in the number of people evacuating the area due to reduced flooding and this is due to the detention tank. Property damage is also reduced and vehicles continue to move. Through social impact assessments, due to this study, public health has been further improved such as reducing stress from flooding, especially for those with small businesses that are flooded and preventing diseases caused by flooding.

The detention tank reduces the economic impact of flooding in the area by providing a proper drainage system to minimize the overflow of water that can damage property. The detention tank helps reduce the cost of building infrastructure for flood control because without a detention tank supporting the drainage, it can overflow and cause widespread flooding or otherwise damage the drainage system. A 2021 feasibility study by Locatelli et al. in Resources, Conservation and Recycling (Italian urban basins), shows that detention tanks with drainage systems reduce the capital cost

for a new drainage system by 25% compared to traditional gray infrastructure. While generating ancillary economic value through job creation in retrofitting projects (estimated at 500-1,000 jobs per large-scale implementation).

Schmitt, Hodges, and Dymond (2020), explore the retrofitting of stormwater detention basins with RTC, noting the potential to reduce peak flows and improve water quality during small to medium storm events. In U.S. and European case studies, these tanks avoided expensive emergency responses, proving cost-effective for aging urban drainage networks. The detention tank with drainage system reduces the cost of repairing damaged infrastructure due to flooding and prevents rainwater from overflowing into drainage systems.

Pumo et al. (2023) investigated blue-green infrastructure paired with detention tanks in semi-arid regions, reporting a 50-60% reduction in stormwater pollutants such as heavy metals and nutrients entering drainage systems .In this research highlights their role in mitigating the impacts of urban stormwater, enhancing biodiversity, and increasing climate resilience through integrated green infrastructure approaches.

According to Tansaret al. (2022), attention has been paid to more sustainable solutions, such as detention tank as part of Sustainable Drainage Systems (SuDS), Low Impact Development (LID) or Blue-Green infrastructure solutions, to attenuate the peak flow of floods and significantly alleviate the problems related to large capital investments in urban flood infrastructure. The main goal of this flood control system is to reduce the overflow of flood water in the drainage systems during rainy or stormy

weather. The goal of this system is also not to disturb commuters or vehicles because it reduces the chance of flooding in the area and also reduces damage to properties that live in that area. Other benefits of detention tanks are their multi-functionality including enhanced live ability, sustainability and value of development areas. These facilities also provide recreation activities and opportunities for residents to engage with the natural environment. Detention tanks can lessen the erosion of downstream channels during flood events.

Local Literature

This section reviews local studies on the use of detention tanks for sustainable flood control and water management systems. This study not only explains the theory of detention tanks and stormwater facilities but also relates them within the unique environmental, social, and infrastructural conditions of the Philippines.

According to Juele, I., & Lapong, E. (2024), the rainwater harvesting system is a key element in sustainable resource management. This study investigates the potential of a rainwater harvesting system to address water scarcity and flooding in Koronadal, Philippines. This study reveals that although awareness of water scarcity and climate change is high, RWHS adoption is hindered by a lack of policy support, financial constraints, technical limitations, and institutional barriers. This study also identifies opportunities for rainwater harvesting to promote sustainable water management, reduce the chance of flood, and reduce the reliance of water from the water distributors.

According to Marzan, D. J. A., Congreso, C. G., Liza, M. L. E., Cano, J. C., Bangao, M. A. T., Guilalas, A. V. P., & Lumas, R. A. R. (2024), Rainwater is regarded as one of the purest sources of water globally. Its quality surpasses that of surface water and is similar to that of groundwater. Additionally, rainwater is safe for non-drinking uses since it does not come into contact with harmful salts and minerals that can affect human health. The quality of rainwater can be influenced by factors such as geographic location, local activities, and the condition of storage tanks; however, with some basic treatment, it can be made suitable for drinking and other household purposes. This study says that utilization of rainwater treatment reduces water demand and helps to reduce the possibility of flood.

Palicpic, M. , Jamon, G. & Villegas, F. (2023), they focused on creating a new design and treatment for the improvement of the existing drainage system of Eli's Business Center at Brgy. Milagrosa, Calamba City Laguna. The main objective of this study was to transfer the waste water of Eli's Business Center to the municipal drainage system. To solve the problem they created sanitary drainage line and directly flush to the municipal drainage system with water filtration.

Etieyibo, E. (2020), The United Nations Framework Convention on Climate Change, an international instrument on climate change, upholds a general duty to protect the climate system, from which developed nations are subject to certain particular duties. The responsibilities of addressing the causes of climate change and mitigating its negative effects are discussed in this paper, followed by the duty to help developing nations that are at risk of these effects bear the costs of adaptation, and, at

last, the duty to support other developing nations by giving them the resources they need to mitigate and adapt to the harm that comes of climate change.

Bañados, J. H. and Quijano (2022), identified possible rainwater retention locations in Mandaue City using a GIS-based analysis. Their results highlighted the importance of retention and detention systems in reducing the risk of urban flooding, especially in densely populated areas. The hydrological planning of the study, they considered the amount of surface runoff, elevation, soil characteristics, land use, and present drainage status of the study area. The Digital Elevation Model derived from LiDAR technology is used to obtain the slope raster and generate small streams. Land cover and curve number of the area were used to compute the surface runoff. The soil textures were converted based on their infiltration rate and runoff potential. Finally, the weighted overlay tool in geographic information system created a layer identifying potential areas for rainwater retention sites.

Foreign Studies

International research also supports the benefits of detention tanks and rainwater harvesting systems. As stated by Silva et al. (2023) analyzed the technical and financial feasibility of rainwater harvesting using both conventional and green roofs in industrial settings. Their results indicated that such systems can deliver long-term cost savings while improving water security.

Custódio and Ghisi (2023) further examined the impact of residential rainwater harvesting on stormwater runoff at a basin scale in Brazil. They found significant

reductions in peak runoff, which highlights how detention systems can reduce urban flood risks when integrated with existing drainage networks.

Abduljaleel et al. (2023) used simulation models to demonstrate how detention ponds can enhance water quality and stormwater management efficiency under climate change conditions. Their study shows that detention systems are adaptable to changing environmental conditions and can provide resilient infrastructure solutions.

Rimer et al. (2023) contributed to the technical aspect of integration by developing a simulation platform for stormwater control algorithms. Their work emphasizes how detention tanks can be optimized using digital tools to improve drainage efficiency and reduce maintenance costs.

Ghisi and Freitas (2024) also assessed the economic feasibility of water reuse systems in multifamily buildings, confirming that stormwater management systems can provide both financial returns and environmental gains.

Together, these foreign studies highlight the adaptability, efficiency, and sustainability of detention tanks. They demonstrate how such systems can be effectively integrated into existing urban drainage networks to optimize stormwater management, reduce flooding, and provide long-term socio-economic and environmental benefits.

Local Studies

A study conducted by Panthaleon et al. (2022) assesed how the rainwater catchment system of uptown communities and their cooperation could increase flood resiliency of downtown communities in the Surigao del Sur, Caraga Region, Philippines which employed quantitative analysis of the eleven (11) year (2010- 2020) data from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration in Hinatuan, Surigao del Sur. Researchers recommend that the optimum rainwater storage capacities for a given number of household occupants, roof areas at run-off efficiency of 90%, and three (3) day rainfall characteristics at 36.9% averaged probability of exceedance were initially determined. They concluded that Integrated residential rainwater harvesting facilities in uptown areas could significantly reduce heavy rainfall and derivatively reduce floods among low-lying communities. Furthermore, it also provides sufficient time for preparation in downtown areas.

Amolato et al. (2024) applied a multi-criteria decision analysis to evaluate rainwater harvesting options in Teresa, Rizal. In the study with a total of 394 of respondents with 184 valid individual respondents expressed interest in using harvested rainwater for flushing toilets, cleaning, and watering plants, concerns regarding mosquito breeding and water quality were evident. Their research shows the importance of community participation in designing water management systems that are both cost-effective and socially acceptable. This aligns with the proposed study

near Petron Saranay, where public acceptance will play a key role in successful implementation.

Boongaling et al. (2024) investigated low impact development (LID) strategies in urban sub-catchments in the Philippines, finding that measures such as detention tanks can significantly reduce surface runoff and mitigate urban flooding. The Research Study consists of 24 major sub-basins draining into Laguna de Bay, the largest lake in the Philippines. Data was gathered with the use of Stormwater Management Model (SWMM) for analysis, planning and design of stormwater management solutions mainly because of its robust accounting of complex hydrologic processes, especially in urban areas. Results showed that the most effective strategies for each land use are (1) combined green roof and bioretention for low-density residential (2) green roof for high-density residential (3) combined rain barrel, bioretention and permeable pavement for industrial (4) combined vegetative swale and detention pond for urban open spaces. The research shows Their work demonstrates the environmental benefits of sustainable drainage systems and supports the integration of detention tanks in existing drainage networks.

In a study by Reyes et al. (2023), the design of the detention tanks is to prevent flooding in Davao City. This research is that if the detention tanks are properly integrated with the drainage systems, it will prevent the risk of flooding by storing water and this can be filtered for alternative uses in bathrooms or watering plants. The study also highlighted the importance of regular maintenance to ensure long-term

functionality. This approach supports efficient integration of detention tanks to maximize stormwater management benefits.

Cruz et al. (2021) conducted a comprehensive study on the performance of detention tanks integrated within the urban drainage networks of Metro Manila. This research shows that detention tanks reduce peak stormwater discharge, thereby mitigating flooding in downstream areas. This study emphasizes the importance of properly sizing detention tanks and where to place them to optimize their effectiveness. Additionally, the integration of detention tanks with existing drainage infrastructure was shown to improve overall stormwater management efficiency, especially during intense rainfall events common in the region.

These local studies collectively suggest that adopting stormwater detention systems in Caloocan City could deliver economic relief to communities, improve social well-being through reduced flooding, and promote environmental sustainability by enhancing water retention and reducing pollution.

Synthesis

The frequency of flooding in Caloocan City, particularly near commercial areas such as Bagumbong Saranay, highlights the urgent need for effective flood management solutions in their area. Recent studies have highlighted that detention tanks integrated with existing drainage systems can reduce the risks of flooding and damage to properties near the floodplain. The design of the detention tank is in

accordance with local hydrological conditions and land use, ensuring optimal storage capacity and efficient flow regulation, which are critical for stormwater management during heavy rains.

In the context of near SM Caloocan, the proposed detention tank design is integrated with the existing drainage system to prevent flooding and the detention tank will be a temporary storage of rainwater. Incorporating site-specific factors such as rainfall intensity, catchment area characteristics, and drainage network capacity is essential to maximize the detention tank's effectiveness. The integration of the detention tank with the existing drainage system is a good way to prevent the overflow of rainwater into the canals and avoid the dangers or diseases caused by flooding in the area.

This research aligns with local studies that advocate for multi-criteria design frameworks and real-time control mechanisms to optimize detention tank performance. It also underscores the importance of regular maintenance and community involvement to sustain the functionality of stormwater management facilities. Ultimately, the design of a detention tank with an integrated drainage system near SM Caloocan represents a practical and sustainable intervention to improve flood control and protect urban infrastructure in Caloocan City.

CHAPTER 3

Research methodology

This chapter is dedicated to discussing research methods and processes. Within this section, the methodology for gathering the required data and information to support the investigation is outlined. The researcher illustrates various techniques for assessing and obtaining vital research data. It discusses the research design, sample and population, research instruments, design and equipment, data gathering procedure, and statistical treatment.

Research design

This study will use quantitative research design. This will be used to assess and design a detention tank with a fire hydrant for flood control in Brgy. Bagumbong, Caloocan City. The data will be gathered through accurate and systematic description of a situation and phenomenon that occur in this particular area. This type of research is particularly useful when the goal is to identify characteristics and frequency within the data set.

Sample and population

This study consists of 50 respondents that will include:

1. **Motorist/drivers** - Randomly selected from private and public vehicle drivers that are main users of the traffic intersection and elevated road.

2. Commuters -Randomly selected commuters using public transport in the area.

Research instrument

In this study, the researcher uses the following equipment to gather all the data required to solve the specific problem in this study.

Survey Questionnaire

To collect a wide variety of information and specific opinions from the various communities affected by the flood and proposed changes. To understand the communities about their insight in the problem with flood and to know if it will be effective.

Software

In this instrument it involves the virtual design of the detention tank including the pump. This also involves the structural design analysis of the detention to determine the performance and the effectiveness of the tank. The use of software will allow the researcher to gather data and easily modify the design of the tank to observe and measure the effectiveness of the detention tank, using software such as autocad and sketch up.

Designing

A detailed 2D and 3D model design will be created to provide an accurate and comprehensive representation of the proposed detention tank and drainage

layout. Using software such as AutoCAD, and SketchUp, the researchers will simulate and analyze the system's behavior under varying conditions of rainfall intensity.

Rainfall intensity

In this instrument it will help the researchers to determine the size and materials that will be used in designing the detention tank. It is one of the critical factors in determining if the tank will be effective. Using the daily weather forecast and past occurrence of rainstorm this will help the researchers also to monitor the effectiveness of the detention tank.

Design and equipment

The researcher carefully examines the equipment that will be used in the system's design. To provide decent information, we used auto cad for the plan view and section view and sketch up to create a 3D design.

Data gathering procedures

In the conduct of the study to collect the data, the research followed some procedures.

a. Preparing the questionnaire given to the respondent.
b. Presenting it to the research adviser and asking for his approval before finally able to reproduce enough copies of the questionnaire intended to the respondent to answer.

c. After the approval, the distribution of questionnaire was done through purely face to face basis

d. Then after administering the given questionnaire to the respondents, the researcher retrieved the collected data.

e. And the last method of data gathering procedure, every data that the researchers gathered from the respondents will be tabulated, interpreted and examine with the accuracy, computed and analyzed to determine the best result.

Software Tools

AutoCAD : A computer-aided design (CAD) used for creating detailed 2D plans and layout drawings of the detention tank and drainage system.

SketchUp : A 3D visualization and conceptual modeling to create a detailed three dimensional model of the detention tank.

Key Performance Metrics

1 **Storage Capacity:** It is the total volume of stormwater that the detention tank can hold during peak rainfall.

2 **Flow Efficiency:** refer to the rate and smoothness of water discharge through the drainage system to prevent flooding.

3 Structural Stability: The system's ability to withstand hydrostatic pressure, soil load, and structural stress.

4 Water Quality: The physical and chemical characteristics of the detained water to determine its reusability or safe discharge.

5 **Storage Capacity:** It is the total volume of stormwater that the detention tank can hold during peak rainfall.

6 **Flow Efficiency:** refer to the rate and smoothness of water discharge through the drainage system to prevent flooding.

7 Structural Stability: The system's ability to withstand hydrostatic pressure, soil load, and structural stress.

8 Water Quality: The physical and chemical characteristics of the detained water to determine its reusability or safe discharge.

Statistical treatment

1. **Percentage and Frequency Distribution.** To determine and analyze the profile of the respondents in terms of age, sex, occupation, residence type, and flooding experience. It is used to determine the quantitative relationship in the total response.

Below is the formula for the given statistical method.

P=f/n x 100 Where:

P - is the percentage and frequency distribution

f - is the frequency

n - is the total number of respondents

2. **Weighted Mean.** It is used to analyzing and interpreting the data collected from the respondents.

$$\bar{X} = \frac{\sum (f \times w)}{N}$$

Where:

- $\bar{X}$ = weighted mean
- f = frequency of each response
- w = assigned weight (e.g., 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree)
- N = total number of responses

3. **Independent T-test**. This study will analyze and compare the responses of residents and non- residents regarding to the current condition of the drainage system and benefits of proposed detention tank with drainage system near SM Caloocan City. The survey included statements related to flood control effectiveness and potential social and environmental benefits, with respondents rating on their level of agreement.

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}}$$

Where:

- t: The t-statistic, which is the value you calculate.
- $\bar{x}_1$: The mean of the first sample.
- $\bar{x}_2$: The mean of the second sample.
- s_1: The standard deviation of the first sample.
- s_2: The standard deviation of the second sample.
- n_1: The number of observations (sample size) in the first group.
- n_2: The number of observations (sample size) in the second group.

DATA PRIVACY STATEMENT: This survey is conducted in accordance with the Data Privacy Act of 2012 (Republic Act No. 10173). All information gathered will be treated with strict confidentiality and will only be used for academic purposes. Your participation is voluntary, and by answering this questionnaire, you consent to the use of your responses for research analysis.

INSTRUCTION: Please read each statement carefully and indicate your level of agreement by checking the box that best describes your opinion. There are no right or wrong answers. Kindly answer all items honestly.

Part I. Demographic Profile of Respondents

Instruction: Please provide the following information by checking the appropriate box or filling in the blanks.

1.1 Age

☐ Below 18 years old
☐ 18–25 years old
☐ 26–35 years old
☐ 36–45 years old
☐ 46 years old and above

1.2 Sex

☐ Male
☐ Female
☐ Prefer not to say

1.3 Occupation

☐ Student
☐ Employed (Private Sector)
☐ Employed (Government)
☐ Business Owner
☐ Unemployed
☐ Other: _____

1.4 Type of Residence

☐ Owned House
☐ Rented Apartment/Condominium
☐ Company-Provided Housing
☐ Informal Settlement
☐ Other: _____

1.5 Flooding Experience
How often do you experience flooding in your area?
☐ Never
☐ Rarely
☐ Occasionally
☐ Frequently

Part II. Current Condition of the Drainage System near SM Caloocan City

Instruction: Please rate the following statements using the scale below.

Flood Control Effectiveness	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The drainage system effectively prevents flooding during heavy rainfall.					
2. The drainage system is regularly maintained to ensure proper function.					
3. The system effectively reduces the risk of property damage due to flooding.					
4. Flooding rarely disrupts transportation and business operations					

5. The drainage system can handle the volume of stormwater during extreme weather.					

Part III. Benefits of a Detention Tank with Drainage System

Instruction: Rate how you agree with the possible benefits of a proposed detention tank and drainage system.

3.1 Social	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The project improves public safety during heavy rain.					
2. Fewer floods make residents feel more comfortable and secure.					
3. The system prevents disruption of work and school activities.					
4. The drainage improvement enhances public convenience.					
5. The project promotes community cooperation in flood control.					

3.2 Environmental	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The system reduces surface runoff and soil erosion.					
2. The detention tank supports groundwater recharge.					
3. The system reduces contamination of nearby rivers or canals.					
4. The drainage design supports sustainable urban development.					
5. The project contributes to environmental conservation.					

Certificate of validation

This is to certify that the questionnaires on our study entitled,

"DESIGN OF DETENTION TANK AND DRAINAGE SYSTEM FOR STORMWATER MANAGEMENT NEAR SM CALOOCAN CITY" originally owned by Group E-7, namely: Jolo M. Domingo, Jandy D. Ecao, Jerann C. Lagundi, Emilyn S. Lancero has been assessed and validated on 4th of November 2025.

Validated by:

11/4/24

Engr. Jore Gil D. Galeza, Ph.D., MEM, SO2
Civil Engineering Professional

Engr. Eloisa P. Cadag, CE, MACT
Civil Engineering Professional

11/07/25

Engr. Russell R. Llagas
Civil Engineering Professional